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Ohio Agricultural Research and Development Center, Wooster

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The Maumee River was chosen by PLUARG to be one of four pilot watersheds to be studied on the U.S. side of the Great Lakes drainage basin as part of Task C- pilot watershed studies.

This report represents the results of the continued monitoring of three of the Defiance County watersheds and the Hoytville plots for the period 1978-1980.

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THE MAUMEE RIVER BASIN PILOT WATERSHED STUDY

Volume III
Continued Watershed Monitoring (1978-80)

by

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ABSTRACT

Monitoring, which was started in 1975 as part of the PLUARG Task C Pilot Watershed Study in the Maumee River Basin of Ohio, was continued in 1978-1980 on three small watersheds in Defiance County and eight plots in Wood County. Runoff and tile drainage were monitored for flow, suspended solids, total P, filtered reactive P(FRP), NH_3-N and NO_3-N.

Runoff and soil loss (4388 kg/ha) continued to be greatest on the poorly drained Paulding soil compared to other sites with spring-seeded crops, but winter wheat on the Paulding site greatly reduced runoff in 1979 and there was no runoff with wheat in 1980. Wheat in 1980 on the other two Defiance watersheds did not affect runoff. No till soybeans on the Blount soil in 1978 reduced erosion to near zero (66 kg/ha) compared to previous years with fall-plowed soybeans where sediment yields ranged from 900 to 2500 kg/ha. Runoff volume with no till, however, was not measurably different than with fall plowing and filtered reactive P loads with no till were no different than fall-plowed FRP loads.

Tile drainage had no effect on runoff volume from Hoytville soil, and no till contineud to have no effect on soil loss compared to fall plowing on this soil where soil losses have been low (< 750 kg/ha) throughout the study. Phosphate fertilizer broadcast in the fall on the no till and fall-plowed Hoytville plots every year from 1975-1979 steadily increased total and FRP concentrations and loads in this period. FRP loads decreased rapidly in 1980 after fall fertilization was terminated.

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1. INTRODUCTION

The Maumee River was chosen by PLUARG to be one of four pilot watersheds to be studied on the U. S. side of the Great Lakes drainage basin as part of Task C - pilot watershed studies. Since there was already an ongoing PL-92-500 Sec. 108 demonstration project in Black Creek basin, an Indiana tributary to the Maumee, the Task C project was directed to the Ohio portion of the Maumee to supplement the work being done in Black Creek.

The objectives of PLUARG were to determine the effects of prevailing land use practices on pollution entering the Great Lakes. Specifically, the PLUARG Task C objectives were to answer the following questions:

1. From what sources and from what causes (under what conditions, management practices) are pollutants contributed to surface and ground water?
2. What is the extent of pollutant contributions and what are the unit area loadings by season from a given land use or practice to surface or ground water?
3. To what degree are pollutants transmitted from sources to boundary waters?
4. Are remedial measures required? What are they and how effective might they be?
5. Were deficiencies in technology identified? If so, what is recommended?

The Maumee River Basin is primarily agricultural in land use, and the intensive crop production in the Basin accounts for most of the sediment and a major part of the nitrogen and phosphorus delivered to Lake Erie (Corps of Engineers, 1975; Sonzogni et al, 1978). Because of the importance of agriculture as a source of pollutants in the Maumee Basin, it was decided

to place emphasis in the Task C project on soil and nutrient loss from small agricultural watersheds and on specialized studies on sediment transport.

Specific objectives of this study were:

1. To determine the effects of land use practices on the loss of sediment and associated chemicals from representative small agricultural watersheds in the Basin and to compare these data with downstream reference samples.
2. To study and determine the physical, chemical, and mineralogical properties of major soils in the Basin and relate these data to their susceptibility to erosion and fluvial transport.
3. To determine the physical, chemical, and mineralogical properties of suspended sediments and bottom sediments in order to identify fluvial transport mechanisms and to evaluate equilibrium stabilities of minerals in suspended and bottom sediments.
4. To determine phosphate sorption-desorption and precipitation interactions with sediment characteristics and concentration levels.
5. To determine heavy metals leaving small agricultural watersheds as contrasted to downstream reference sources.

The results of this study (1975-1977) have been published previously (Logan and Stiefel, 1979; Logan, 1979) and the reader should consult them for more complete details of the study results. This report presents the results of the continued monitoring of three of the Defiance County watersheds and the Hoytville plots for the period 1978-1980.

1.1 Study Approach

The basic approach of this study was to measure the generation of sediment and nutrients from intensively cultivated cropland under prevailing management practices. The study investigated the differences in pollutant generation on several of the major soils of the Maumee Basin and determined the effects of season and soil characteristics on sediment and nutrient generation. Pollutant transport by tile drainage was also studied because of the extensive use of underground tile for drainage in the Basin.

1.2 Study Methods

Five sites were chosen in Defiance County on four major soils of the Basin (Figure 1 and Table 1) ranging from 0.6 to 3.2 hectares in the area. Surface runoff was monitored at all sites and tile drainage on the Paulding and Blount sites. A continuous-flow monitoring system and integrated sampler were used so that all events were monitored and sampled. The sampling period was from January, 1978 - May 1980. Rainfall was monitored at each site. At the OARDC branch research station in Wood County, eight plots (0.04 ha) on Hoytville soil were subjected to a number of different tillage treatments, and runoff and tile drainage were monitored.

1.21 Monitoring Sites in Defiance County

Five small agronomic sites were chosen in Defiance County to monitor soil and nutrient loss under prevailing crop management practices. The sites represent four of the more important series in the Basin: Paulding, Blount, Roselms and Lenawee (similar to Latty). The sites were selected with the following criteria:

1. Topography was typical for that series
2. The watershed was dominated by a single series

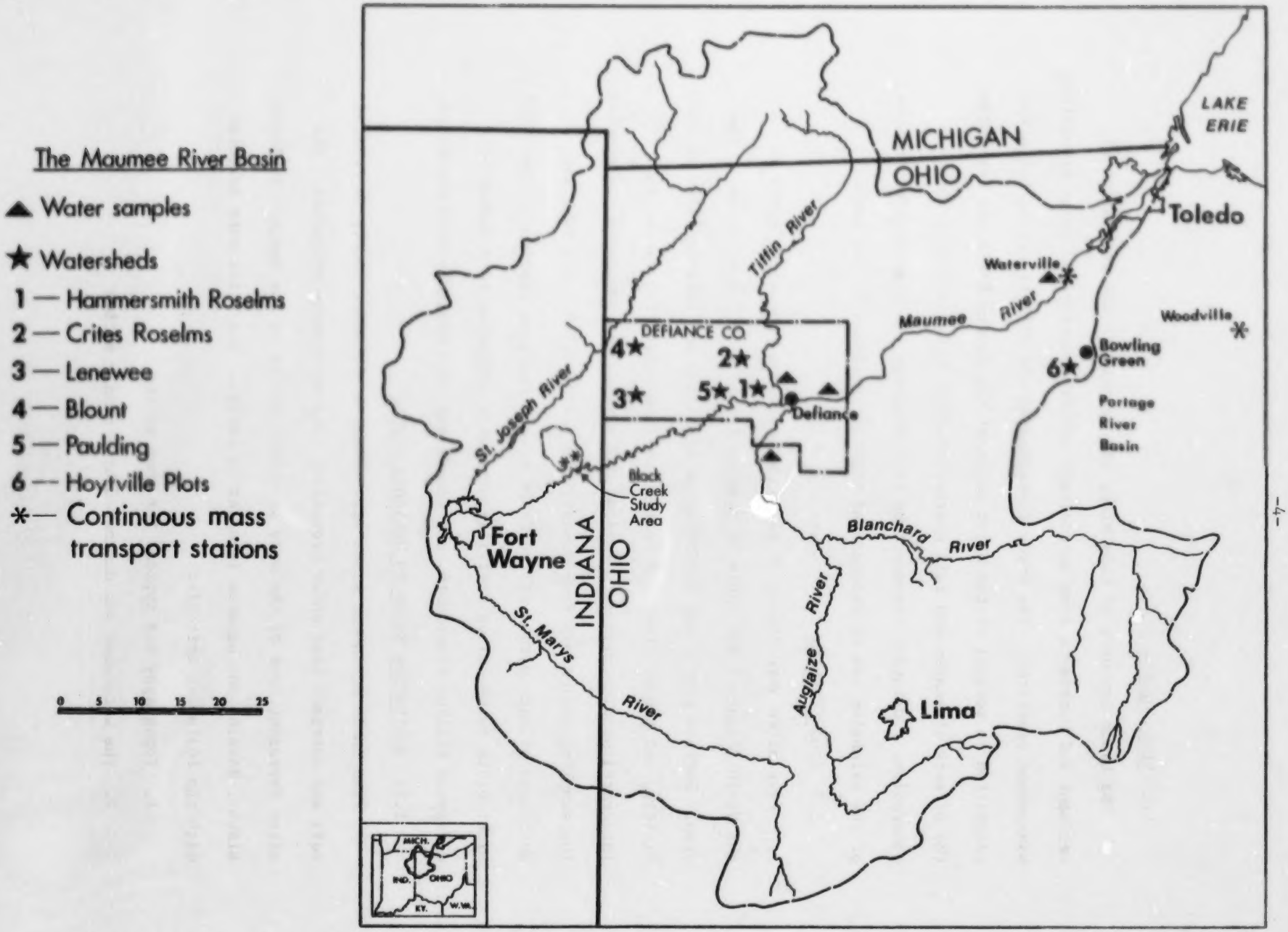


Figure 1. Watershed and plot locations in the Maumee River Basin.

Table 1. Characteristics of the Defiance County watersheds (111, 401, 501) and Hoytville plots monitored in the period 1978-1980.

Site Code	Dominant Soil Series	Soil Taxonomy	Physiographic Region	Parent Material	Slope (%)	Drainage Area (ha)	Drainage Systems Monitored
111	Roselms	Aeric Ochraqualf	Lake Plain	Lacustrine Clays	3-16	3.2	Surface Runoff
501	Paulding	Typic Haplaquept	Lake Plain	Lacustrine Clays	1	1.0	Surface Runoff
502	Paulding	Typic Haplaquept	Lake Plain	Lacustrine Clays		0.1	Subsurface Tile
611-681	Hoytville	Mollic Ochraqualf	Lake Plain	Clay Till	< 1	0.04	Surface Runoff
612-682	Hoytville	Mollic Ochraqualf	Lake Plain	Clay Till		0.04	Subsurface Tile
401	Blount	Aeric Ochraqualf	Till Plain	Clay Loam Till	3-4	0.9	Surface Runoff
402	Blount	Aeric Ochraqualf	Till Plain	Clay Loam Till		0.9	Subsurface Tile

3. The watershed could be defined hydrologically
4. There were no septic tank or livestock waste discharges within the watershed
5. Cooperation from the landowner was available
6. Site was accessible from the road, had adequate flow outlet, and electrical service could be brought to the site.

Using these criteria, a large number of sites were examined and five were selected. These were described in detail by Logan and Stiefel (1979) in their report on the 1975-77 monitoring period. In the 1978-80 period reported here, only the Hammersmith Roselms (111), Heisler Blount (401, 402) and Speiser Paulding (501, 502) watersheds and the Hoytville plots (60X) were monitored. A detailed description of the properties of the watershed soils has been previously given by Logan (1979).

Table 1 summarizes the site characteristics and Figure 1 identifies their location. A more detailed description of each site is given next. A 3-digit code was used to identify the sites and for identification of samples from each site:

First digit: 1-6 identifies the primary site

Second digit: 0-8 identifies the sub-site within the primary site

Third digit: 1 refers to surface runoff and 2 to tile drainage, which were monitored separately.

Hammersmith Roselms (111): This site is located in the central area of Defiance County and in the lake plain. The soil and plot map is given in Figure 2, and the area is shown in Figure 3. The drainage area is 3.2 ha (8.0 acres) and is composed of Roselms on most of the area with Broughton on the steep slopes. The watershed has a well-defined drainageway (Figure 3),

Hammersmith Roselms (10X)

Location: Noble township, T4N, R48, Sec. 6, NW¼

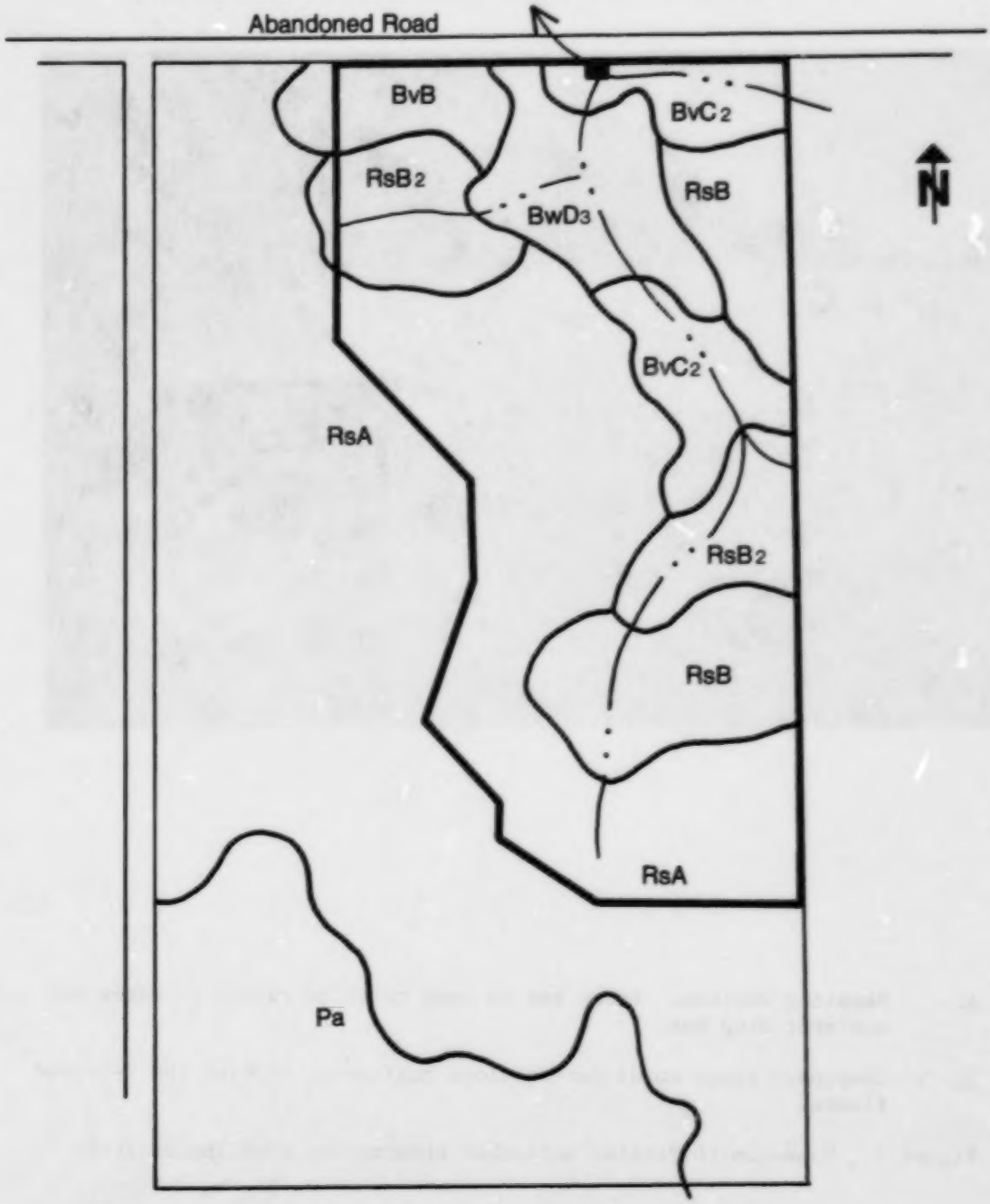
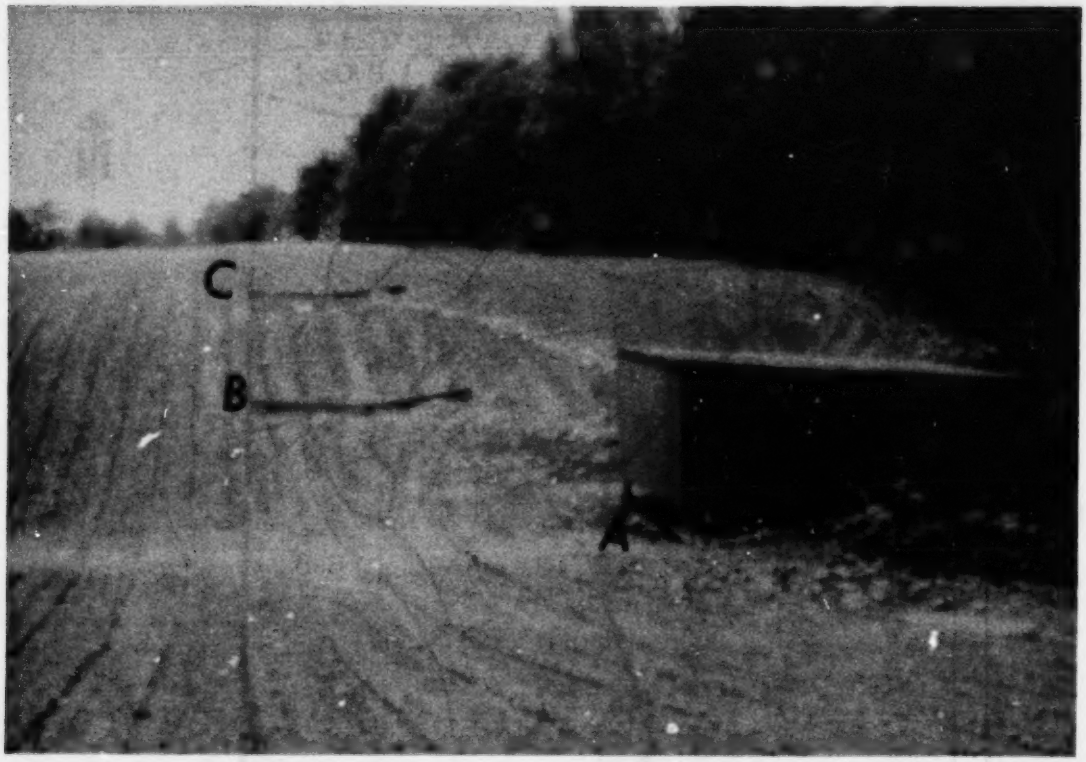


Figure 2. Layout of Hammersmith Roselms watershed. (Heavy line denotes the monitored area).



A: Sampling shelter. Front end is open to allow runoff to enter the sediment drop box.

B, C: Component plots on different slope positions, showing the V-shaped flumes.

Figure 3. Hammersmith Roselms watershed showing the sampling shelter.

and the monitoring system is placed at the point where the drainageway exits the watershed. Slopes vary from 1-3% on the more level part of the watershed to as high as 15 % where the landscape breaks into the drainageway.

Heisler Blount (401, 402): This site is located in the northwest corner of Defiance County and is in the till plain region of the Maumee River Basin. The soil and plot map is given in Figure 4 and the watershed is illustrated in Figure 5. The area is bermed on the upslope perimeter and on the lower side to channel the flow toward the flume. The upper part of the site is Blount loam while the lower end is Mermill loam, which represents the unconsolidated soil eroded from the top of the slope and deposited downslope. The surface drainage area (401) is 0.8 ha (2.1 acres). A previously installed tile system was also monitored (402), and the drainage area has been estimated to be between 2 and 4 acres. The tile drainage pattern shown in the plot diagram (dotted lines) (Figure 4) is only speculative.

Speiser Paulding (501, 502): This site is located in the southcentral area of Defiance County in the lake plain region. The soil and plot map is given in Figure 6 and the area is illustrated in Figure 7. The major part of the plot is occupied by Paulding-Roselms clay, a series which has all the characteristics of a typical Paulding clay but whose clay content is minimal for Paulding. About a third of the plot is Paulding clay itself. The surface-drained area (501) is 0.9 ha (2.5 acres) and was defined by throwing up a berm. This soil is normally surface-drained by using shallow field ditches, and in this instance, the ditches were used to carry surface runoff to the sampler. Three tile drains were installed 12.7 m apart and 1 m deep.

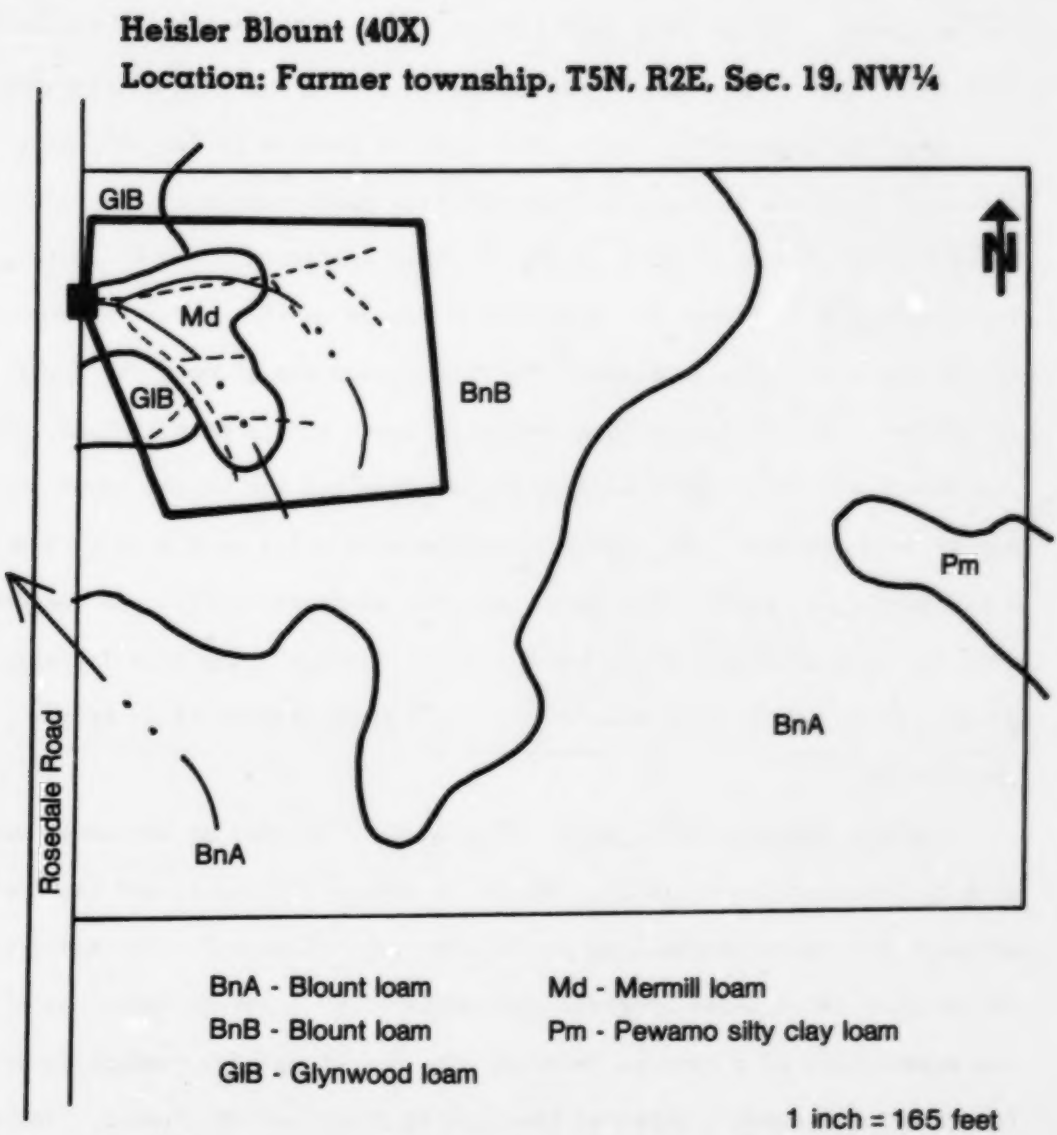


Figure 4. Layout of Heisler Blount watershed (Heavy line denotes the monitored area and dotted lines are tile.)

Figure 5. Heisler Blount watershed looking downslope.

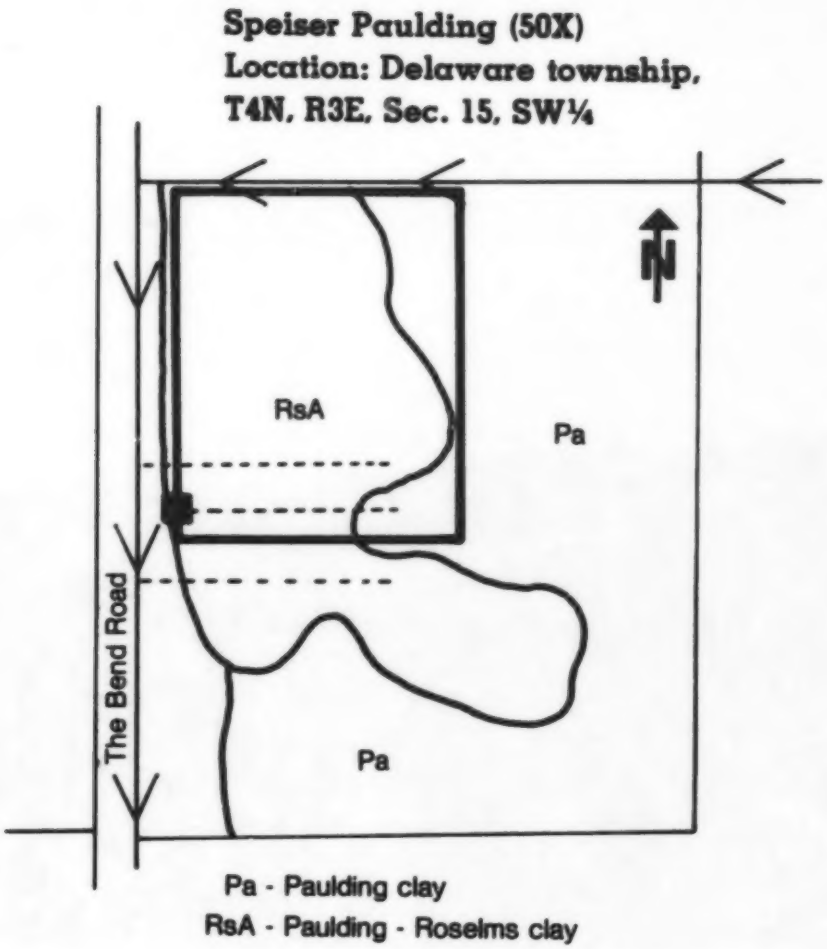


Figure 6. Layout of Speiser Paulding watershed (heavy line denotes monitored area and dotted lines are tile.)

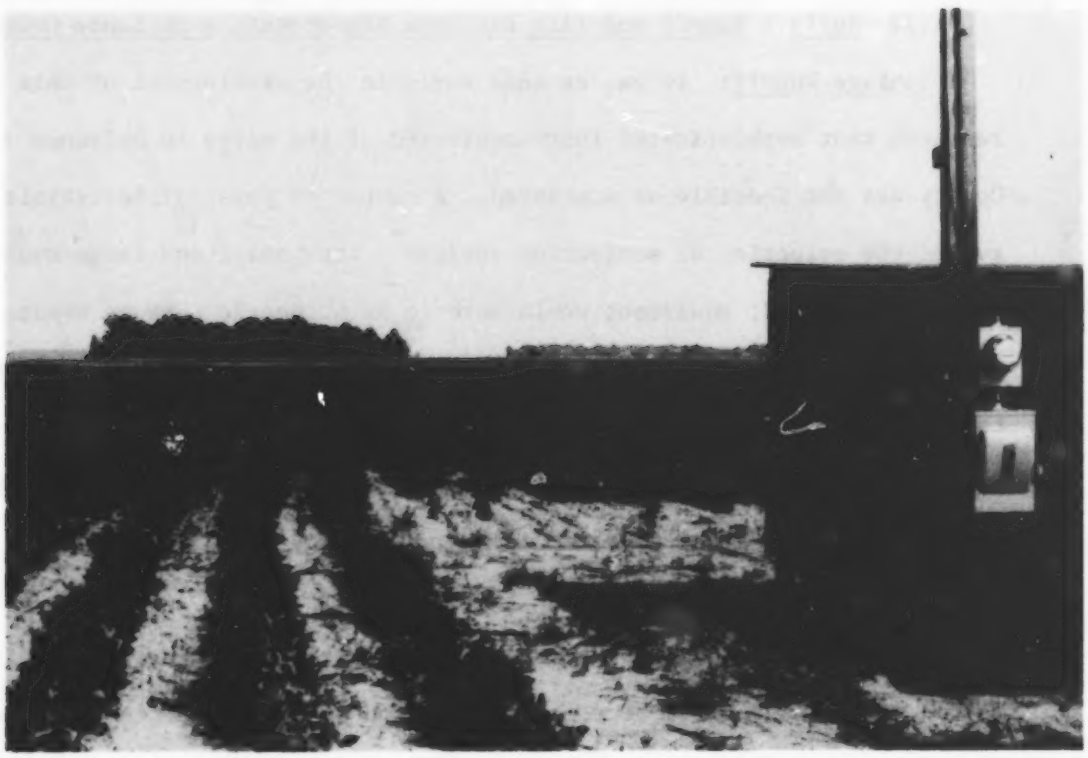


Figure 7. Speiser Paulding watershed showing the sampling shelter.

The central tile, 55.7 m (220 feet), was monitored with a drainage area of 0.09 ha (0.23 acres).

1.22 Surface Runoff and Tile Drainage Measurement - Defiance County Sites

Surface Runoff: It was decided early in the development of this research that sophisticated instrumentation of the sites in Defiance County was not feasible or warranted. A number of physical restraints guided the selection of monitoring devices: both small and large events must be monitored; equipment would have to be automatic because events on small areas are very rapid and the sites had to be serviced by a single technician; it was important to be able to operate in the winter because much of the runoff occurs in the initial storms after thawing in the early spring; there was a general lack of hydraulic head at all sites. The system that was developed had the following basic principle: the runoff was channeled over a drop structure and a known fraction of the flow was intercepted. The intercepted flow was then passed over a Coshocton wheel, which intercepted another fraction. This water then discharged into a sump. A sump pump of known discharge rate (gallons per minute) was activated when water in the sump reached a given level. The pump was connected to a timer, which recorded time of pumping. The water was pumped up into a container from which a sample could be taken. By knowing the fraction of total runoff intercepted and the pump rate and time of pumping, total runoff in a given interval was calculated. The sample taken from the pump discharge represented runoff for that interval. Samples were taken after each event.

A diagram of the equipment used is given in Figures 8, 9 and 10. Figure 8 shows a standard SCS concrete drop-box, which is used to carry runoff from surface drains to the stream or drainage ditch without causing

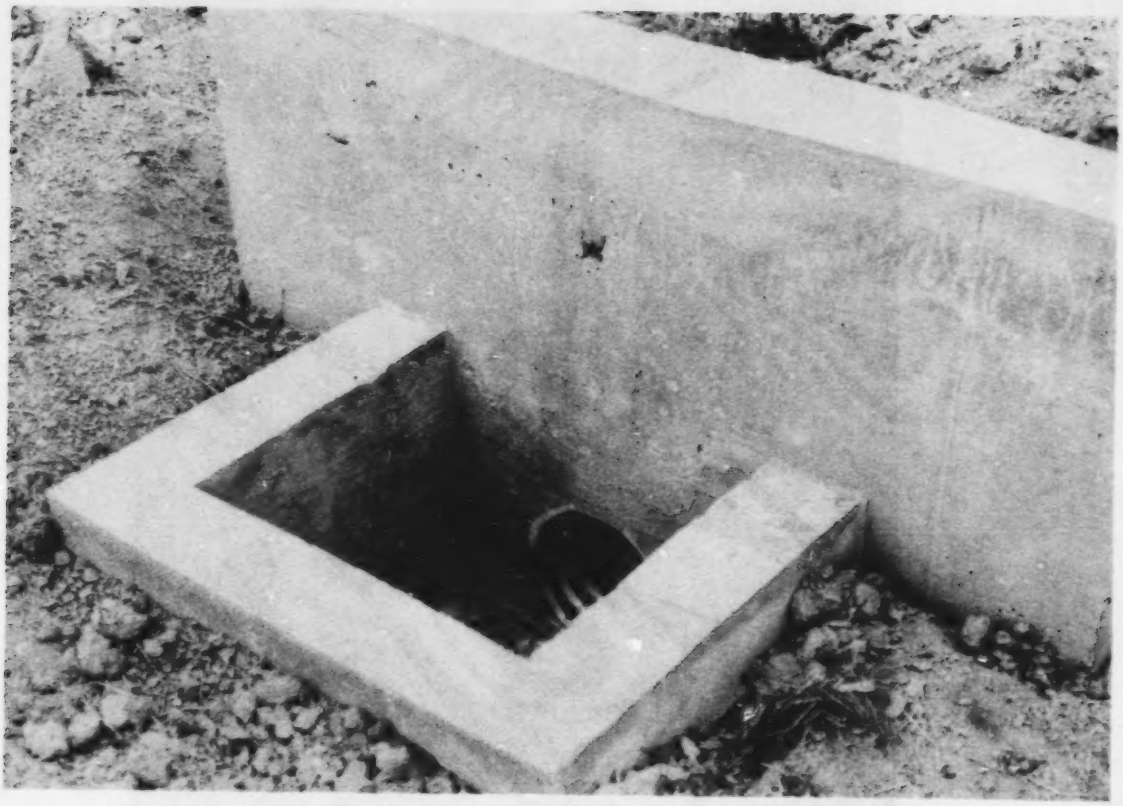
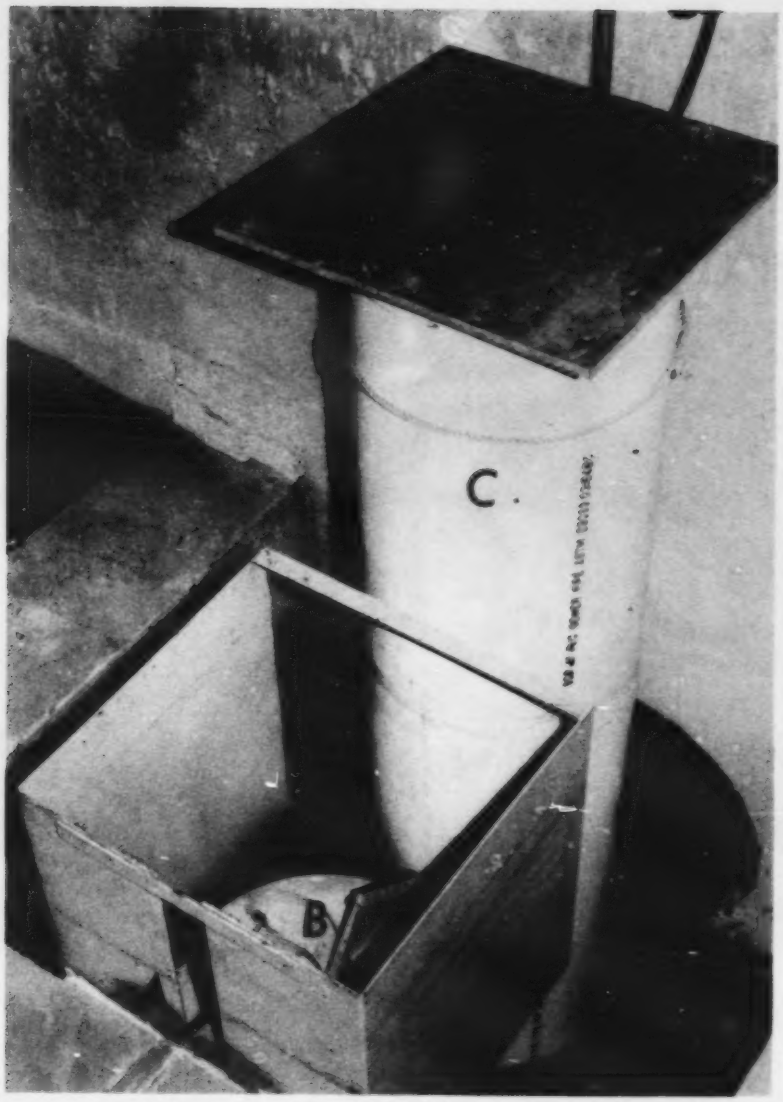


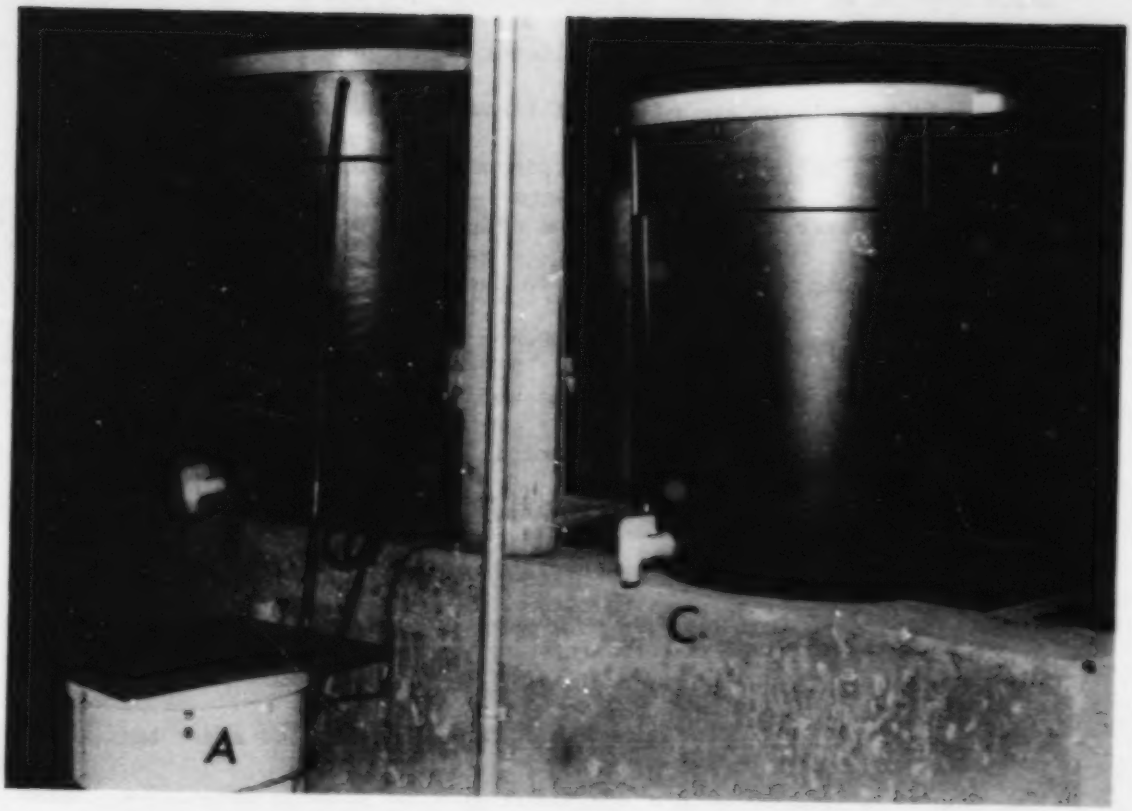
Figure 8. Sediment drop box used to collect runoff from Defiance County watersheds.



A: Variable slit flume which diverts fraction of runoff into Coshocton wheel (B).

C: Sump collects discharge from Coshocton wheel; discharge is then pumped into sample container (Figure 13).

Figure 9. System for monitoring and sampling surface runoff at Defiance County watersheds.



A: Sump for collecting runoff. Contains sump pump which discharges into sample container (B).

C: Sample container for tile drainage.

Figure 10. Sample containers for runoff and tile drainage at Defiance County watersheds.

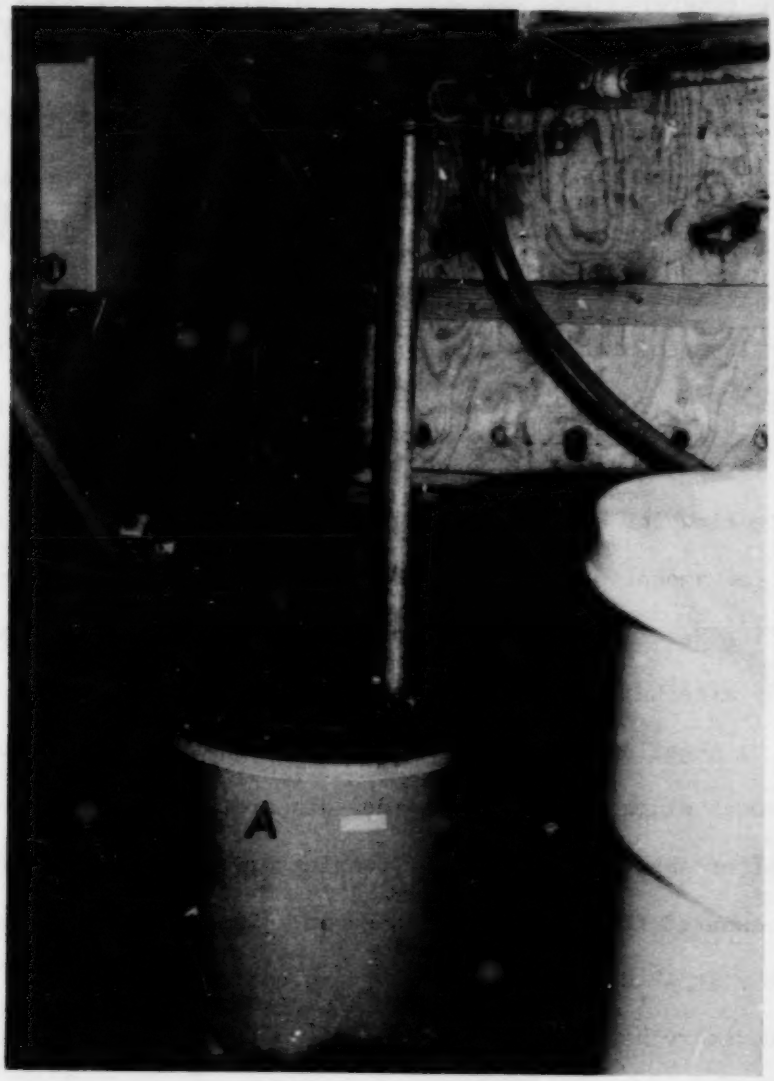
undue erosion of the bank. A similar structure was used at all five sites in Defiance County. The perimeter of the box was levelled so that flow would be uniform around it. A flume with adjustable vertical slit (Figure 9) was bolted to the front rim of the drop-box. The runoff from the slit fell over a Coshocton wheel (Figure 9) and then from the Coshocton wheel into a sump which was bolted to the floor of the drop-box (Figure 9). The runoff was pumped by a "Haynes Demon Drainer" submersible pump. This particular model was used because it would pump to near dryness and this prevented an accumulation of sediment in the sump. Recovery of sediment was tested in the laboratory during the development and calibration of this equipment and was found to be acceptable. The pump was activated by electrodes set to turn on when approximately 0.1 inch of runoff was recieved. The pump could also be activated manually. The pump was connected to a timer, which could either accumulate pumping time or be reset between events. The runoff was pumped into a 20-gallon plastic garbage can with a fitted lid (Figure 10). After each event, a subsample (usually 1 gallon) was taken from the container by a faucet at the bottom after thorough mixing. The remaining sample was discarded. The entire system was housed in a shed open only at the front, where the drop-box faced the field. The equipment was winterized by the use of heat lamps directed onto the Coshocton wheel and mounted in the sump and garbage lids. Heating tape was used for all pipes. Even during the extremely low temperatures of 1977, the system never failed to operate during winter events.

Tile drainage. In all cases, a single tile line was monitored, except for the Blount site (402), where a small tile system was monitored by intercepting the main at the point where it discharged into the drainage

ditch. The tile was usually at a depth of 1 meter, and a specially constructed fiberglas sump was set into the ground in the same sampling shelter used for surface runoff. The sump (Figure 11) intercepted the tile and collected all discharge. As in the case of surface runoff, a calibrated sump pump was used to pump the water out of the sump. A timer was used as before to measure pumping time, and the pump was activated at a given water level by electrode; it could also be activated manually. An orifice inserted into the discharge pipe from the pump delivered a sample of the water to a 20-gallon plastic garbage can, where it was subsampled as described previously. This sample was considered to be representative of the tile flow for a given time interval, since all of the flow was sampled. The amount of sample taken by the orifice was adjusted by a valve.

Sampling Handling and Processing - All sites in Defiance County were serviced by a technician every 48 hours or sooner if significant precipitation occurred. A 1-gallon subsample of the sample in the garbage can was taken after thorough mixing and the remainder discarded. Sumps were pumped dry manually after subsampling, time of pumping was recorded and rainfall at the site was measured from a manual rain gauge. Samples were stored in a refrigerator at 4^{o} C at field headquarters until they could be transported to the laboratory at Columbus. Samples usually reached the laboratory within 7 days or less. Additional measurements taken in the field included depth of snow cover, depth to frozen soi and all pertinent details on field operations (times of planting, plowing, harvesting, rates of fertilization, etc.).

Cropping Practices - The following cropping practices were employed by the cooperating farmers on the Defiance County watersheds in 1978-1980:



A: Fiberglas sump which intersects field tile. Contains submersible sump pump with flow-activating electrodes.

B: Sampling valve which diverts portion of sump pump discharge into sample container.

Figure 11. System for monitoring and sampling tile flow.

Hammersmith Roselms (111) - Fall chisel every year. In 1978 and 1979 soybeans was the crop. In fall of 1979 wheat was planted. Grassed waterway was established in fall of 1979.

Heisler Blount (401, 402) - In 1978, no till soybeans were grown. Residue cover was good because of a heavy weed infestation in the previous year which was killed with paraquat prior to no till soybeans. In fall of 1978, the watershed was chisel plowed and soybeans grown in 1979. In fall of 1979, the watersehd was planted to wheat.

Speiser Paulding (501, 502) - Fall molboard plowed every year. Oats were grown in 1978, followed by wheat in 1979 and 1980. The oat crop was fertilized with 33 kgN/ha and 15 kgP/ha just after seeding.

1.23 Surface Runoff and Tile Drainage Measurement — Hoytville Plots

In 1974, a research facility was constructed at the NW Branch, Ohio Agricultural Research and Development Center (OARDC), located at Hoytville in Wood County (Figure 1), to study the loss of soil and nutrients by runoff and tile drainage. Eight plots, each 30.5 m (100 ft) x 12.1 m (40 ft), were laid out, four in a block, with a sampling house in the center (Figure 12). Each plot was trenched to a depth of four feet and heavy plastic sheeting was placed against the plot wall; the soil was then backfilled to hold the plastic in place. Earth berms (15-30 cm high) were raised on the sides of the plots and seeded with fescue. The backs of the plots were left open to allow passage of equipment; a berm was then formed after each operation to enclose the plot. A concrete gutter was built on the other end of the plots with a 10 cm (4 inch) diameter drain to collect runoff. The drain was connected by 10 cm (4 inch) plastic pipe (placed at 90 cm depth) to the sampling house. A 10 cm (4 inch) perforated corrugated plastic tile

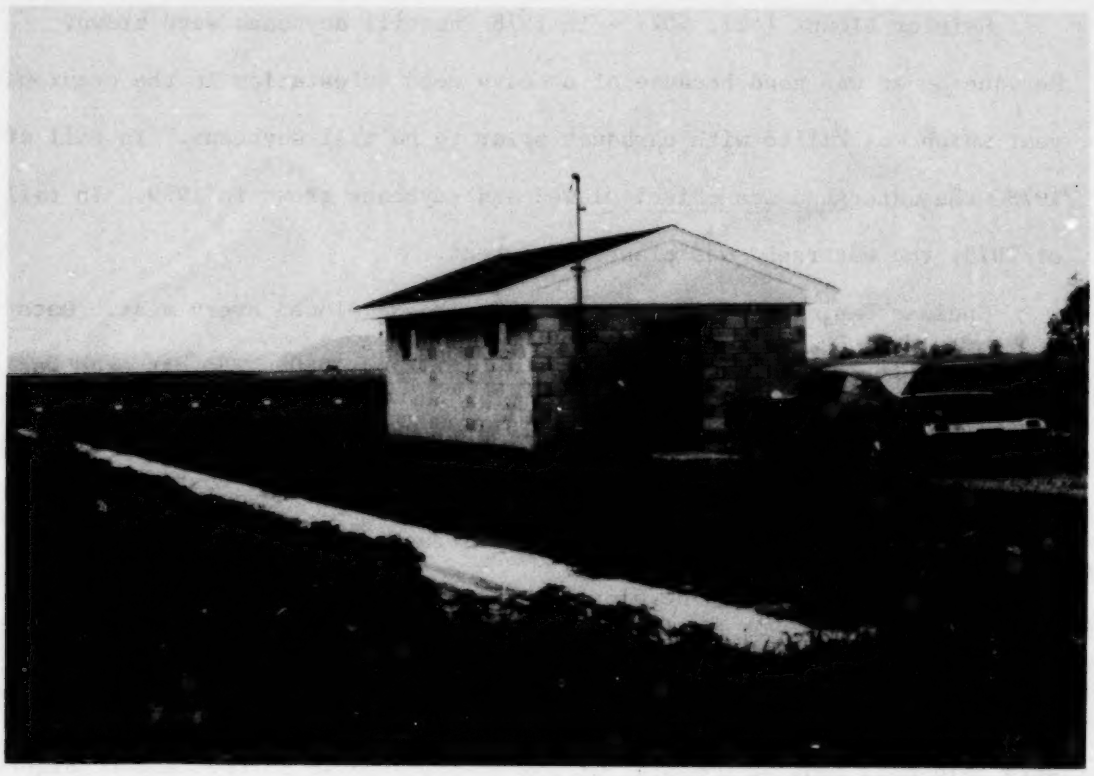


Figure 12. Runoff and tile drainage plots at OARDC Research Station, Hoytville, Ohio.

was installed in the center of each plot at a depth of 90 cm. The tiles were also connected by 10 cm (4 inch) solid pipe to the sampling house. Additional field tile was placed outside the plot area to keep water other than that intercepted by the plots from entering the area. The hydraulic conductivity of the soil (Hoytville clay) was low enough to prevent any significant water movement between plots. The area between the plots and sampling house was seeded with fescue to prevent erosion.

The sampling procedure used was similar to that used to measure tile drainage on the Defiance County sites. Fiberglas sumps intercepted the flow from the surface runoff and tile drain lines. Sump pumps (Hydromatic submersible pump) and timers were used to measure flow as described previously, and water was sampled as before by placing an orifice in the discharge line from the sump pump. The sampled water was collected in 1-gallon or 5-gallon plastic bottles housed in a refrigerated (4° C) compartment so that the samples were refrigerated immediately. Samples were returned to the laboratory at Columbus within 1 week or less. Samplers were serviced daily and sumps were pumped dry between events. Precipitation records were kept by the personnel at the research station which has a 20-year weather record.

The facility was completed early in 1975, and some flow and sediment monitoring was initiated in April 1975; water quality sampling was begun in May 1975. The previous fall, the plots were fall plowed and left bare until planting in May 1975. The area had been in sod for at least 10 years prior to construction of the plots and had received no fertilizer during that period. In May 1975, soybeans were planted and all plots were treated the same through November 1975 to measure variability among the plots. From 1976-1977,

soybeans were grown with varying tillage treatments ranging from fall moldboard plow to no till (Logan and Stiefel, 1979). In November 1977, the tillage treatments were consolidated into fall moldboard plowing and no till, with the previous no till and fall plowing plots continued, and the intermediate tillage plots no tilled or fall plowed. One half of the plots had their tile drainage pump systems disconnected to give four tile drained and four non-tile drained plots. The plots and their treatments were:

Plots	Tillage	Drainage
641, 661	Fall plow	Tile drained
642, 662	"	"
651, 611	"	Not tile drained
621, 671	No till	Tile drained
622, 672	"	"
631, 681	"	Not tile drained

Crop management practices in 1977-1980 are given in Table 2. In 1978 and 1979 corn was grown and then soybeans again in 1980.

1.24 Analysis of Watershed and Plot Water Samples

As soon as samples were received in the laboratory, the 1-gallon polyethylene bottles were shaken thoroughly and a 250 ml sample was placed in another bottle and refrigerated (Figure 13). A 100-ml aliquot of the unfiltered sample was filtered through a preweighed 1.0 um Nucleopore membrane filter. The sediment and filter were oven-dried, reweighed, and sediment concentration calculated. The filtered solution was refrigerated until further analysis. Tests showed that a 1.0 um filter was effective in retaining fine clay. The filtered sample was routinely analyzed for: $(NO_3 + NO_2)$, NH_3, and filtered reactive-P. The unfiltered sample was analyzed for total P. Methods of analysis were discussed in detail by Logan and Steifel (1979).

Table 2. Summary of crop management practices on Hoytville plots (1977-1980)

1977

1. Tillage -	Half of the plots (1, 4, 5 and 6) were moldboard plowed November 7. The other plots (2, 3, 7 and 8) were in no till.
2. Fertilization -	19 kgP/ha was broadcast October 5.

1978

1. Fertilization -	180 kgN/ha as urea broadcast April 14.
2. Tillage -	Plowed plots were field cultivated twice April 28.
3. Planting -	DeKalb XL 64 corn planted in 30 inch rows April 28.
4. Pesticides -	1 kg/ha Furadan (AI) with planter; 2 kg/ha Atrazine, 2 kg/ha Lasso and 2 kg/ha Roundup (no till only) April 29.
5. Harvest -	October 5.
6. Fertilization -	86 kgP/ha broadcast October 30.
7. Tillage -	Fall moldboard plowed (plots 1, 4, 5 and 6) October 31.

1979

1. Tillage -	Plowed plots were field cultivated twice April 23.
2. Fertilization -	179 kgN/ha as anhydrous NH_3 injected April 27. Also 112 kg/ha of 6-24-24 was applied through the planter April 23.
3. Pesticides -	17 kg/ha Counter applied at planting; 2 kg/ha Atrazine, 2 kg/ha Lasso and 1.5 kg/ha Roundup (no till only) applied May 1.
4. Planting -	Landmark C747X corn planted in 30 inch rows April 23.
5. Harvest -	October 24
6. Fertilization -	30 kgP/ha broadcast December 13.
7. Tillage -	Fall moldboard plowed (plots 1, 4, 5 and 6) December 14.

1. Tillage -	Plowed plots were field cultivated twice May 2.
2. Planting -	Williams soybeans planted in 30 inch rows May 2.
3. Fertilization -	112 kg/ha 6-24-24 was applied through the planter May 2.
4. Pesticides -	2 kg/ha Dual 6E, 3 kg/ha Amiben and 1.5 kg/ha Roundup (no till only) applied May 3.

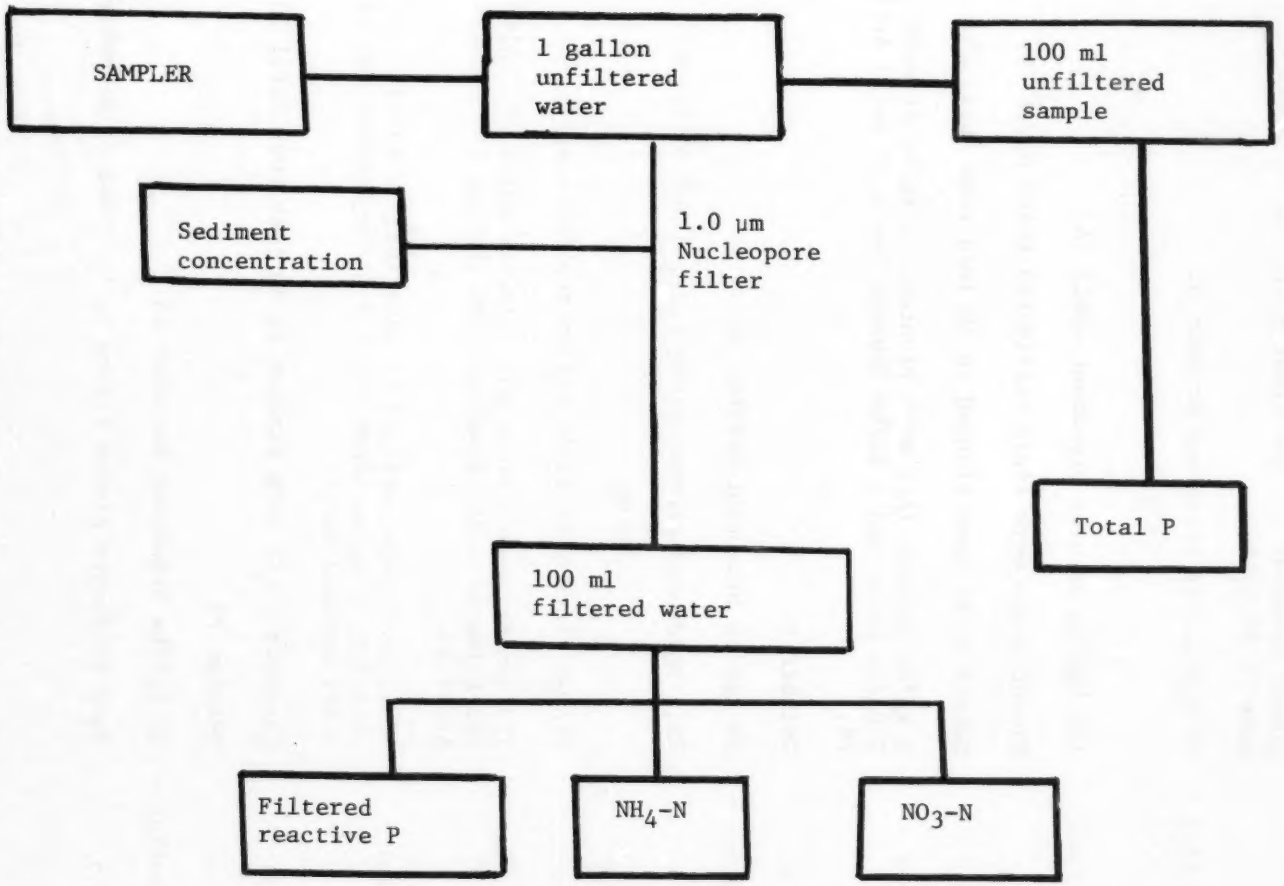


Figure 13. Analytical scheme for water samples.

2. RESULTS

2.1 Precipitation and Flow (1978-1980)

Table 3 gives annual precipitation and flow (surface runoff and tile drainage) for the Defiance watersheds and Hoytville plots. The 1980 data is through May only. Precipitation was lower in 1978 than in 1979, and this is reflected in the flows for these years. Surface runoff was very high on the Roselms site (111) in 1979, but there is no explanation for this increase. However, this is the most precipitation received on this site since monitoring began in 1975.

Runoff and tile flows on the Blount site (401, 402) in 1978-1980 were similar to these monitored in 1975-77. In 1978, no till soybeans were grown on this site as compared to fall-plowed soybeans in previous years and again in 1979. No till appeared to have no effect on runoff and tile drainage flows. The wheat crop in 1980 also appeared to have little effect on drainage flows.

Surface runoff was very high on Paulding soil (501, 502) in 1978 and tile flow very low. This was similar to the results of the 1975-77 monitoring, although the 1978 surface runoff was higher than in previous years. The crop in 1978 was spring seeded oats, and since much of the runoff occurs in late winter and early spring (Logan and Stiefel, 1979), the oats crop would have had about the same effect on surface soil conditions as the soybean crops grown in previous years. In 1979 and 1980, winter wheat was grown on the Paudling watershed and this dramatically decreased surface runoff to 4.2 cm in 1979. In 1980 there was no runoff through May when monitoring stopped. There was also a slight increase in tile flow in 1979-1980 compared to previous years. It would appear that

Table 3. Precipitation and flow from Defiance watersheds and Hoytville plots (1978-1980).

	1978		1979		1980*	
	Flow	Ppt	Flow	Ppt	Flow	Ppt
	cm					
111	23.5	70.9	71.5	87.6	27.7	31.4
401	13.8	67.5	17.0	83.1	9.7	32.4
402	12.2	67.5	9.7	83.1	6.4	32.4
501	52.1	61.6	4.2	89.8	0.0	28.2
502	3.7	61.6	13.7	89.8	8.5	28.2
641/661†	19.9	65.8	23.5	98.7	6.3	28.6
642/662	38.9	65.8	51.9	98.7	16.8	28.6
611/651	28.4	65.8	26.0	98.7	6.8	28.6
621/671	25.1	65.8	30.2	98.7	3.5	28.6
622/672	22.5	65.8	32.4	98.7	16.5	28.6
631/681	29.1	65.8	25.5	98.7	7.8	28.6

* Through May 31.

† Mean of duplicate plots.

this large of a decrease in surface runoff must be due to increased moisture removal with the fall-seeded wheat crop in addition to any increased infiltration capacity that the increased vegetative cover might have provided in the winter-spring runoff period.

In 1978-1980, half of the Hoytville plots were tile drained, while the other half had only surface drainage. There were no significant differences in surface runoff as a result of tile drainage, with either no till or fall plowing. There were also no significant differences in either surface runoff or tile flow between no till and fall plowing.

2.2 Soil and Nutrient Losses (1978-1980

2.21 Hammersmith Roselms (111)

Table 4 gives the mean annual soil and nutrient losses for this site for 1978-80. This soil is on moderate to steep slopes (2-15%) and is high in clay. In 1975-77, soil loss varied from 1284 to 3714 kg/ha. Loss in 1978 was similar to this, but 1979 and 1980 losses were higher, especially the 1980 soil loss which was only for the period January-May. In fall 1978, an attempt was made to establish a grassed waterway in the natural draw which drains this watershed (Figure 3). The fescue stand was only partly established by spring of 1979, and was reseeded in fall 1979 and again in spring 1980. In addition, wheat was seeded on this watershed in fall 1979 and the wheat was seeded across the waterway to increase vegetative cover. By winter 1979, there was an adequate stand of wheat and fescue in the waterway. However, neither the grassed waterway nor the wheat crop had any effect on soil loss; in fact soil loss increased in 1979-80.

Table 4. Concentrations and pollutant loads from Hammersmith Roselms (111) surface runoff.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	3741	16	667	1395	5100	0	755	4801	5133	868	2375	5848
Filtered reactive-P	0.47	0.02	0.09	0.18	0.15	0.00	0.02	0.09	0.95	0.04	0.35	0.86
Total-P	2.15	0.00	1.37	2.86	2.05	0.16	0.41	2.59	--	--	--	--
(Nitrate + nitrite)-N	2.3	1.1	2.0	4.3	12.0	0.0	1.2	7.2	13.3	3.3	5.4	13.3
Ammonia-N	0.6	0.0	0.2	<0.1	1.0	0.0	0.1	0.1	0.6	0.0	0.3	0.2

*Flow weighted mean concentration (FWM)

Nitrogen and phosphorus losses were similar to those in 1975-77 and were quite low. This watershed has been in soybeans and wheat for the six years of the study and has received no nitrogen fertilizer in this period and very little P and K.

2.22 Heisler Blount (401, 402)

Mean annual soil and nutrient losses in surface runoff (401) and tile drainage (402) are given in Tables 5 and 6, respectively. Soil losses in 1975-1977 varied from 890-3400 kg/ha. In 1978, no till soybeans were grown in a mixture of soybean and killed quackgrass sod (surface residue was > 50%). No till reduced soil loss to 66 kg/ha, essentially zero at the level of detection of this study. As discussed previously, this reduction was not a result of runoff volume, which was not greatly different than previous or subsequent years, but was due to the greater protection of the soil surface by the residue cover. In 1975-77, total P loads varied from 1.14 to 2.33 kg/ha, and in 1978 this was reduced to 0.37 kg/ha as sediment load was reduced. However, filtered reactive P (FRP) loads were unchanged with no till. Loads ranged from 0.02-0.08 kg/ha in 1975-1977 when the watershed was plowed, and was 0.08 kg/ha with no till in 1978.

2.23 Speiser Paulding (501, 502)

Nutrient and sediment losses for 1978-1980 are given in Tables 7 and 8. In the period 1975-1977 this watershed had the highest soil loss of all sites studied and ranged from 3849 to 4576 kg/ha/yr. Soil was fall plowed and soybeans were grown in these three years, and the high soil loss was attributed to the high clay content and poor structure of this soil together with the lack of subsurface drainage (Logan and Stiefel, 1979). As previously discussed, oats were grown in 1978 followed by wheat in 1979 and 1980. Table 3 showed that runoff volume in 1978 was similar to previous years, but

Table 5. Concentrations and pollutant loads from Heisler Blount (401) surface runoff.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	95	0	53	66	1184	48	390	515	1365	511	1265	1092
Filtered reactive-P	0.13	0.04	0.07	0.08	0.07	0.00	0.03	0.04	0.72	0.04	0.49	0.43
Total-P	0.37	0.16	0.30	0.37	0.51	0.26	0.31	0.47	--	--	--	--
(Nitrate + nitrite)-N	4.8	0.9	2.2	2.7	8.0	2.3	5.0	7.5	0.0	0.0	0.0	0.0
Ammonia-N	0.9	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Flow weighted mean concentration (FWM)

Table 6. Concentrations and pollutant loads from Heisler Blount (402) tile drainage.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	66	0	34	37	222	0	131	112	197	0	73	41
Filtered reactive-P	0.28	0.01	0.09	0.10	0.20	0.00	0.08	0.07	0.14	0.02	0.07	0.04
Total-P	0.79	0.10	0.30	0.32	0.56	0.00	0.27	0.23	--	--	--	--
(Nitrate + nitrite)-N	35.8	0.0	8.3	8.9	27.0	0.9	13.9	11.9	18.0	1.7	13.7	7.7
Ammonia-N	0.9	0.0	0.2	0.2	0.6	0.0	0.6	<0.1	0.8	0.0	0.4	0.1

*Flow weighted mean concentration (FWM)